Syllabus for Corrosion Class MSNE 569, Rice University, spring semester 2016

Provided on the first day of class in hard copy and Owl-space.

1. Class taught by: Dr. Randy C John
   - His office will be in the MSNE department office in the second floor of George R Brown Hall, email is johnrandy14@yahoo.com or randy.john@rice.edu
2. Class will meet in MEB 128 on Mondays and Wednesdays from 11:00 a.m. – 12:15 p.m. An alternate or extra class day/time will be selected and announced with class participation and will be used in the event class is not held on a scheduled day (except for days affected by University-wide cancellation of classes). If Dr John is not able to attend a regular class meeting on either Monday or Wednesday, then a make-up class will occur on Friday of that week in MEB128 from 11:00 a.m. – 12:15 p.m.
3. Dr John is on Rice campus with an "open door" policy Mondays and Wednesdays from 10:00 a.m. – 3:30 p.m. in the MSNE office in second floor of George Brown Hall and by appointment as needed. Meetings to discuss course contents or career issues are welcome.
4. Course objectives for the students are to learn the basics of the science of corrosion and to become familiar with typical applications in industries. Topics to be discussed and to be mastered include awareness and understanding relating to the following:
   - Industrial examples of failed corrosion strategies and the consequences
   - half-cell reactions, anode, cathode, faraday's law, corrosion units, 8 forms of corrosion
   - electrolytes, interfaces, double layer, electrode potential, reference electrodes. measurements
   - thermodynamics review, free energy, Gibbs' energy, chemical potential, Nernst equation
   - thermodynamics of corrosion, electrochemical cells, galvanic corrosion, (fuel cells and batteries)
   - aqueous - Pourbaix diagram calculations, water, metals with water, alloy examples, limitations with corrosion
   - aqueous - kinetics, weight change, measurement methods, polarization, anodic/cathodic protection
   - aqueous - passivity, theories, surface analysis, effects of alloying elements
   - aqueous - crevices, pitting, occluded cells and mechanical aspects, stress corrosion cracking forms
   - aqueous - inhibitors, acids, neutral solutions, and coatings (nano applications)
   - gases - thermodynamics, phase diagrams, phase stability diagrams, electrochemistry, testing
   - gases - forms of corrosion (carburization, nitridation, HTHA, oxidation, sulfidation, molten salts, molten phases, halogens, mixed mode)
   - examples of corrosion from several industries

Home work will be the problems at the end of each chapter and will be completed/submitted to the instructor at the beginning of the first class of the following week. Questions and answers will be submitted. Late work will not be

graded, unless approval is given before homework is due.

Additional homework, each student will summarize the importance of some element groups of the periodic table with respect to corrosion issues of metals and alloys. The groups are: 1) alkalis, 2) alkaline earths, 3) light metals, 4) group 8 transition metals, platinum group, 5) precious metals, solders, 6) refractory metals and 7) halides. Produce a summary of 2-3 pages per group. Students will be assigned a group, results will be graded and shared.
Due Wednesday Jan 25 , plus a table of melting points and costs.

Expected learning outcomes for the student are to learn the vocabulary and analysis tools to define the key aspects of a corrosion situation, to recommend a course of action for analysis and to decide a plan for remediation.

5. Grade policies
   - All materials to be graded should be presented to the instructor on the due date announced.
   - Materials should be submitted no later than the beginning of class time of the due date announced.
   - Exceptions for late submissions should be discussed with the instructor before the due date.
6. Absence policy
   - Students are expected to attend all classes.
   - Regular attendance and productive/positive class participation may influence final course grades. Not all materials presented are found in the text book.
7. Required text book

   Introduction to Corrosion Science by E. McCafferty
   Hardcover: 302 pages
   Publisher: Springer; 2010 edition (May 11, 2010)
   Language: English
   ISBN-10: 1441904549
   ISBN-13: 978-1441904546

   Prices are about ebook $70, used $58 and new $66. Some links for purchases are below.
   http://www.amazon.com/Introduction-Corrosion-Science-E-McCafferty/dp/1441904549
   http://www.springer.com/us/book/9781441904546
   https://store.kobobooks.com/en-US/ebook/introduction-to-corrosion-science
   https://books.google.com/books/about/Introduction_to_Corrosion_Science.html?id=g9oXcE-gQKUC
   http://www.ebooks.com/1156106/introduction-to-corrosion-science/mccafferty-edward/
8. Special materials required for the class
   - none
9. Required examinations and papers
   - Final collaborative team project materials to be graded will include a package of presentation slides and a team oral presentation, topic and team to be selected by instructor – 25%
   - Two course exams, in class – 25% each exam
   - One quiz, in class – 10%

- Exams will be in class and tend to be long. Check for commitments at end of class.
- Homework items from each chapter discussed in the course and submitted at beginning of the first class of the following week and extra items requested and tend to appear on exams – 15%
- Course schedule is attached as a table.
- Class before exams will be review.

10. Statement of expectations regarding course work and the Rice Honor Code
    - Homework assignments may be done in collaboration with student colleagues
    - Cell phones and electronic communication devices will be switched off during class time.
    - Exams in class time are expected to be individual efforts, shall not involve collaboration with students and may not include use of any resources not approved
    - The final team project assignment will be done in collaboration with team colleagues and individual contributions will be identified. Team project grade will include equally weighted portions of individual contribution and teamwork contributions.
    - All course work should be of high quality in presentation and information contained; should indicate the assignment; should show the logical assessment of the problem statement, the analysis done, the final conclusion/recommendations; and full reference citations of all background/source materials used in the effort.
    - Materials submitted for course requirements will be neat, orderly, complete, well prepared and submitted on the required date, unless alternate arrangements made before the due date.
    - Survey of course/instructor performance will be done at course mid-point.
    - The Rice honor code shall apply.
11. Any student with a disability that requires accommodation should contact both the course instructor and Disability Support Services in the Allen Center.
12. Information contained in this course syllabus, other than the absence policies, may be subject to change with reasonable advance notice, as deemed appropriate by the instructor and announced to the students.
13. Students needing special accommodations to due physical limitations are encouraged to communicate this need to the instructor as soon the need becomes known to the student. The intent is to comply with the ADA statute.
14. Chapters in the text book should be read in advance of the week's lectures.
15. Estimate 3 hours of personal study/homework time for each hour in class.

To address ABET student outcomes and program criteria, the students will have

(a) An ability to apply knowledge of knowledge of mathematics, science and engineering
(b) An ability to identify, formulate and solve engineering problems

The curriculum will prepare graduates to apply advanced science (such as chemistry, biology and physics), computational techniques and engineering principles to materials systems implied by the program modifier, e.g. ceramics, polymers, biomaterials, composites materials; The subject materials specific to this course will be corrosion science and the application of these principles to corrosion engineering materials principles in industrial applications. Graded student materials for the team project will demonstrate completion of the above requirements.

Syllabus for Corrosion Class MSNE 569 Spring 2016 At Rice University

	Week	Week #	Book Chapter	Corrosion engineering class content, lecture topics	Exams
introduction	Jan. 11	1	1	why, what, how, Periodic table, alloying elements, major engineering alloy families (Fe, Ni, Al, Cu, Ti, Co, Pb, Zn), simple metal costs and melting points, industrial examples of poor corrosion	
chemistry	Jan. 18	2	2	half cell reactions, anode, cathode, faraday's law, units, 8 forms of corrosion	
	Jan. 25	3	3	electrolytes, interfaces, double layer, electrode potential, reference electrodes. Measurements	quiz on Periodic table - 10%
	Feb. 1	4	4	thermodynamics review, free energy, Gibbs' energy, chemical potential, Nernst equation	
	Feb. 8	5	5	thermodynamics of corrosion, electrochemical cells, galvanic corrosion, (fuel cells and batteries)	exam - 25%
aqueous corrosion	Feb. 15	6	6 and extra diagrams	Pourbaix diagram calculations, water, metals with water, alloy examples, limitations with corrosion	
	Feb. 22	7	7 and 8	kinetics, weight change, measurement methods, polarization, anodic/cathodic protection	survey students
	Mar. 7	8	9	passivity, theories, surface anlysis, effects of alloying elements	
	Mar. 14	9	10 and 11	crevices, pitting, occluded cells and mechanical aspects, stress corrosion cracking forms,	
	Mar. 21	10	12 and 13	inhibitors, acids, neutral solutions, and coatings (Nano)	assign team projects
gas phase corrosion	Mar. 28	11	15	thermodynamics, phase diagrams, phase stabilty diagrams, electrochemistry, testing	
	Apr. 4	12	extra - RCJ article	forms of corrosion (carburization, nitridation, HTHA, oxidation, sulfidation, molten salts, molten phases, halogens, mixed mode)	exam - 25%
corrosion in industry	Apr. 11	13	extra	oil / gas / refining and aerospace (turbines, structures and nano coatings)	
	Apr. 18	14	extra	civil infrastructure (concrete, steel) and power generation (water treatment, combustion and steam turbines, fired equipment, structures, nano coatings)	team reports 25% and course survey

Each team project will analyze an industrial corrosion control question, broken into pieces for each student, prepare an assessment summarized in a presentation with background, summary of major issues and recommended mitigation plan approach: assign task, review at midpoint and 10 minues presentation in class. Homework is 15% of the course grade.